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"DE-LOUSING" SHRIMP

There is a tiny blue-and-white shrimp in the Bahamas that lives on the "lice" that infest fishes, sets up permanent de-lousing stations to which louse-plagued fish make regular visits like men to barber shops, and which advertises its places of business by swaying from side to side and vigorously waving its exceptionally long white antennae in the water to attract transient customers.

Specimens of this shrimp, discovered by Vern and Harry Pederson and collected a few months ago in the Bahamas by Conrad Limbaugh of the Scripps Institution of Oceanography of La Jolla, Calif., have just been added to the marine invertebrate collections of the Smithsonian Institution.

The phenomenon of fish de-lousing by other sea organisms often has been described and probably is world-wide. This, however, is by far the most complex case ever reported. The shrimp, as described by Mr. Limbaugh, "sets up shop" on the head of a sea-anemone, flower-like member of the coral family, whose petals are stinging tentacles. These tentacles protect

the tenant from all natural shrimp predators. The anemone, in turn, cannot survive without the presence of another species of shrimp at its base.

The de-lousing shrimp cleans its fish customer meticulously from head to tail of parasitic copepods, the so-called "lice of the sea," often almost invisibly minute, which infest most marine higher organisms. It also removes other minute parasites and cuts away small patches of dead tissue. It works inside and out. The fish helps the shrimp to forage within its gill cavities, mouth, and throat by opening them one at a time as the forager approaches them. It also allows the "barber" to make minor incisions in its skin to get at parasites which have bored into the flesh.

Apparently such a shrimp always does a rushing business. The fish cleaned react to the waving tentacles by approaching the cleaner, stopping or slowing down. They even assume awkward positions, seemingly as if hypnotized. Sometimes certain varieties may change colors. Often they will fight for the right to be cleaned, or "having firsts" on the barber chair, and there are vicious battles. More docile forms crowd one another, sometimes completely obliterating the cleaner from view.

Mr. Limbaugh is engaged in an essentially world-wide study of fish-cleaner organisms. There is, he reports, considerable variation in the complexity of the phenomenon which seems to have arisen, in its various forms, over long periods of evolution. Nothing hitherto reported, however, has approached the complexity of the Bahama case. There may be, however, other organisms that maintain permanent cleaning stations. These, indeed, may constitute a very important phase of sea biology. The stations may be set up on individual coral heads, on reef formations, in sea floor depressions, or merely in certain general areas."

Certain species of fish and other organisms, as well as shrimp, engage in this cleaning activity. "In general," Mr. Limbaugh reported recently to the Western Society of Naturalists, "the concept may be expanded to include very large areas or physical features. I am now convinced that this is one reason fish visit the edges of kelp beds, where species of cleaner fish dominate the fauna. I believe also that many famous fishings grounds (off the Pacific coast) may be cleaning stations. Among these I would include certain islands and shoals." He continues:

> Visiting fishes at the small cleaning stations in the Bahamas showed a definite time pattern in their daily arrival, obviously related to a diurnal patterned life. Longer term studies undoubtedly would have shown seasonal trends. The number of fish processed at a small station during a six-hour daylight period may be large, up to 300 for one cleaning fish. In areas inhabited by thousands of cleaner organisms, the numerical significance begins to take on meaning. Often a fish will visit more than one station and return many times during the day. This is particularly true of an injured or sick fish.
>
> In an experiment in the Bahamas, I removed all the known cleaners from two small isolated reefs where fishes were particularly abundant. Within a few days the numbers of fish were drastically reduced. Within two weeks all except territorial fishes had disappeared. Many of these developed white fuzzy blotches, swelling, ulcerated sores and ravaged fins. Later small shrimp and juvenile fish cleaners appeared. Most of the original fish did not return but were replaced by juveniles.
>
> Known organisms involved as cleaners in the sea include eight families of 21 species of fishes, several families of shrimps, involving six species, a worm, a bird, and a crab. Relationships of cleaners to the cleaned organisms frequently are so casual as to seem accidental, but in other cases it involves integrated and complex behavior. In warm seas, cleaning organisms generally are colored to contrast with their environment. In general they are solitary, paired or slightly gregarious. In temperate waters they are not brightly colored or contrastingly marked. Often they are highly gregarious. They are more numerous than in warmer waters but there are fewer species.

GENERAL SCIENCE.—*Moon bound.*[1]

RAYMOND J. SEEGER, National Science Foundation.

(Received January 2, 1959)

Man always has been and still is moon bound. From earliest times he has been fascinated by the very appearances of the moon. The baby in his crib reaches for the bright moon; the child in the nursery wonders at the "man in the moon." A Hebrew story tells that this man was banished to the moon because he picked up sticks on the Sabbath; his sticks are now the shadows on the moon. Young men yearn for a "lady in the moon," and old men dream of "the old moon in the new moon's arms." Literature[2] abounds in fanciful speculations about the moon, for example, writings of Dante, Ariosto ("Orlando Furiosa"), Milton, Jonson ("News from the New World Discovered in the Moon"), Shakespeare, Donne, Keats ("Endymion"), Rostand ("Cyrano de Bergerac"). Men have always been susceptible to wonderful stories about this wonderland. One of the most celebrated was the so-called "moon hoax," which appeared in an August issue of "The Sun" in 1835. R. A. Locke, a newspaperman, reported that Sir John Herschel had just discovered flying men and animals on the moon by means of a new large telescope in Africa. The only truth about the whole account was the rapid increase in the newspaper circulation. Nevertheless, beneath man's superficial stories is a genuine curiosity as to just what is on the surface of the moon.

As man became interested in nature for its own sake, he felt a burning desire to "save the appearances," to uncover the φύσις (physics) beneath the φαινόμενα (appearances). For example, in Plato's educational program for the future leaders of his Republic, he discussed the merits of astronomy as a possible subject, not for its applications in agriculture or in navigation, but because of its relation to the intelligible principles behind phenomena. For centuries man had been observing the irregular planetary and lunar motions. He saw chaos, he sought to unveil cosmos; he looked for order amid the apparent disorder. It was the fall of a meteorite near Aegos Potamoi in 467 B.C. that stimulated Anaxagoras's interest in the heavens as a sequence of understandable events. He visualized moonlight as reflected sunlight; he explained the phases and eclipses of the moon. Above all, he regarded the surface of the moon as earthlike. For this very reason this first philosopher of distinction in Athens was banished in the so-called golden age of Pericles for impiety. It was Hipparchus of Nicea who determined later (about 129 B.C.), parallactically, the distance of the moon from the earth (within 0.1 percent of the modern value).

The telltale telescope of Galileo revealed the nature of the heavens in a dramatic way comparable to that of the visible Sputnik—far more compelling than any theoretical speculation. The announcement of the moon's appearance was made in the Siderius Nuncius. In the church of Santa Maria Maggiore in Rome, a portrait of the Virgin shows a small picture of the moon as first glimpsed by Galileo. There one sees outlined the mountains of the moon; for example, the Apennine range, 450 miles long and with 3,000 peaks such as Huygens (19,000 feet high). Galileo himself estimated the mountains to be about 4 miles in height. All these ranges have familiar European names; for America had not yet been explored in detail. If the moon's hidden face is ever revealed to us, mountain ranges there will undoubtedly be named after those on our Western Hemisphere. One observes also many large flat regions, which have been given fanciful names: the Sea of Serenity, the Ocean of Storms, the Bay of Rainbows, the Lake of Death, et al. A moot scientific

[1] Luncheon address given at the "Unveiling of the Moon Building," Sheraton-Carleton Hotel, Washington, D. C., October 28, 1958.

[2] GODWIN, F. *The man in the moon.* 1638; WILKINS, J. *The discovery of a world in the moon.* 1638; BOHN, A. *The emperor in the moon.* 1687; FOWLER, G. *A flight to the moon.* 1813; WELLS, H. G. *First man in the moon.* 1901; COFFIN, C. M. *John Donne and the new philosophy.* 1937; ALLOT, K. *Jules Verne.* 1941; NICOLSON, M. *Voyages to the moon.* 1948.

question today persists as to whether these areas are actually lava flows or dust bowls. Particularly striking are craters such as Archimedes, which is 40 miles in diameter and which could have been formed by a meteorite having a weight of 25 billion tons. For comparison, we think of Meteor Crater in Arizona, which is less than a mile wide and which is supposed to have been produced by a meteorite of only 200,000 tons. Sad to relate, Galileo too suffered imprisonment at the end of his life of research of the heavens. His view of the moon and other celestial phenomena did not agree with the socially accepted doctrine of his times.

There is an apocryphal story that Newton conceived his theory of gravitation when he was struck by an apple falling from a tree. There might have occurred to him the thought: "Suppose it had been the moon; suppose the moon were an apple!" "In such a case," he might have surmised, "moons and apples would be subject to the same law of gravitation—a universal law." In any event we have all come to believe that we do live in a universe with laws that apply equally to moons and to apples.

In more recent times, a Washingtonian, Simon Newcomb (1835–1909), director of the Nautical Alamanac from 1877, became so fascinated by lunar motions as to investigate them in considerable detail. You recall that tidal slowing of the rotating earth (about 0.001 second in a century) results in an increasing angular acceleration and consequential recession of the moon about ten centimeters each month. Even today lunar motions still present a formidable challenge to man, including the earth-moon enigma that these two bodies might have been closely associated about 5 billion years ago. More amazing than our ignorance, however, is our knowledge about the moon and other astronomical phenomena. How unbelievably well has man succeeded in "saving the appearances"—without ever going to the moon! Laplace's remark is still worth considering: "Because of the majesty of its subject and the perfection of its theories astronomy is the most beautiful monument of the human spirit, the noblest claim of its intelligence."

It is not surprising, therefore, that much science fiction has been written with respect to our nearest neighbor in space. A particularly interesting book was written in 1900 by Newcomb himself.[3] It tells of a Harvard professor of molecular physics who began about 1941 a secret project in a brickyard on a nearby Potomac Island. Later he expanded his operations to the island of Elba, where he built Uraniberg (a heavenly city) in the tradition of Tycho Brahe. His unique invention was a space ship, which had been made possible by the discovery of a new material called etherene. Its reaction with ether vibrations was conceived to be analogous to that of the wings of a bird with the air through which it flies. A new source of energy, therm, akin to electricity, was also available. The time came for the unveiling of the motes, as these space ships were called (hi motes traveled a hundred miles high). Newcomb noted that Professor Gale, an English physicist, believed such motion to be impossible owing to air friction. He overcame this difficulty by flying the ships above the atmosphere, the height of which was found on flight to be greater than that previously calculated. On the occasion of the unveiling, formal invitations were sent to the President of the United States, to the heads of the several Government departments, to members of the Judiciary, to high officials of the Army and Navy, as well as to presidents and professors of various universities. A dinner was arranged in their honor prior to the unveiling ceremony. About one-third of the individuals offered excuses for not coming, another third came in order to see who the third third really were that could be seriously interested in such a subject. The book concluded by revealing the true motivation of the project and its secrecy; it was aimed at the establishment of a "defender of the peace of the world." In the same spirit, United States satellites today are rightly called Explorers and Pioneers, for they are much more significant as rockets for peace than as missiles for war. So much for the superscience of Newcomb's fiction!

In a strictly technical paper[4] on "The Outlook for the Flying Machine," Newcomb

[3] NEWCOMB, S. *His wisdom—the defender*. 1900.
[4] NEWCOMB, S. *Sidelights of astronomy*. 1906.

reviewed later (1906) Langley's aircraft failure. He concluded, "Let us discover a substance a hundred times as strong as steel, and with that some form of force unsuspected which will enable us to utilize this strength, or let us discover some way of reversing the law of gravitation so that matter may be repelled by the earth instead of attracted—then we may have a flying machine. But we have every reason to believe that mere ingenious contrivances with our present means and form of force will be as vain in the future as they have been in the past."

Truth has once again turned out to be stranger than fiction. The accomplishments of our age surpass not only the sober expectancy of great scientists of yester years but even their science fiction. I wonder what Simon Newcomb would say if he knew that we are now shooting for the moon.

In all our technological development, however, we need to distinguish carefully both between science and science fiction, and between science and technology. We speak of these times as a space age. Yesterday it was an atomic age. In neither case has it been truly a scientific age. At a meeting of the Federal Schoolmen's Club in Washington last year, a talk was given about satellites. At the end two educators asked these questions: (1) "What keeps the satellite up?" (2) "What keeps it going?" Mind you, 300 years after Newton had told clearly how well-behaved moons travel in public space!

What is science? It is not information, please! It is not mysterious gadgetry! It is not powerful magic! Science, i.e., knowledge, is the result of the use of the scientific method, a method that is peculiar to the scientist. May I stress again that the "what" of science is less important than the "how" of the scientific method, all of which is meaningless except in terms of the "who," the scientist that observes, that relates, that imagines. As Henri Poincaré once said, "Science is no more a collection of facts than a house is a collection of stones." The end of science is a comprehensive view, an imaginative vista, an interpretive theory. Its means is a workshop, i.e., a laboratory. Work, let us remember, can and should be adventuresome; it can and should be wonder-full; it can and should be joy-full. The scientist in his laboratory is akin to the artist in his studio; to the child in his kindergarten. Science, above all, can and should be fun-full; for science is exploration. With our modern satellites we are now abel to reach the upper atmosphere, the very edge of the earth, where we meet incoming cosmic rays and meteors from outer space.

The surface of the moon is a member of our planetary family that affords unusual physical conditions. The very lack of an atmosphere, as indicated by the sharpness of the moon's shadows, allows incoming radiation there to be free from atmospheric influences. The surface, too, is free from erosion although it undergoes large temperature changes from minus 243° F. to plus 214° F. on a single day. It is evident that any design for building on the moon must necessarily be quite different from that on the earth. For example, gravitational force there is only one-sixth as great so that the weight of building materials will actually be less on the moon than on the earth. The inertial mass, however, remains the same. Consequently, vibrational phenomena, which involve both gravitational stresses and inertial masses, will behave quite differently from those upon the earth.

We moderns are literally moon bound. We dream of Luniberg, a city on the moon, with buildings that are truly out of this world. We visualize a lunar observatory for man's penetration into the space about him and his reflection upon the earth he has left behind him.

Meanwhile, as we stand moon bound on the earth, let us all insist upon a scientific outlook!

BOTANY.—*Supplementary studies in* Aeschynomene, *I: Series Viscidulae, including a new species and five new varieties.* VELVA E. RUDD, U. S. National Museum.

(Received February 13, 1959)

A considerable number of *Aeschynomene* specimens have come to my attention since publication of "The American Species of Aeschynomene" (Contr. U.S. Nat. Herb. **32**: 1–172. 1955). Some of these specimens are old, representing collections that have been ascribed to "familiar," widespread species without critical examination or that have spent years in the limbo of "indet" folders. Others are types and historical collections that I did not have access to earlier.

Among such specimens I find a few that I believe to represent new taxa and others that amplify the concepts of the old. This paper is essentially a recapitulation of the *Viscidulae* series of the genus *Aeschynomene*, but without repetition of detailed descriptions and explanations of synonymy given before. Included in this treatment is the description of one new species and five new varieties, presentation of a new specific name for an old variety, and reinstatement of two old specific names that have been kept in synonymy for a century or so. Material from the Old World is also considered. A revised key is provided.

For the material on which this study is based, I am deeply grateful to the curators of the herbaria cited, for their help in providing types and other pertinent specimens. The initials of the herbaria, as cited, are those of Lanjouw and Stafleu (Index Herbariorum, ed. 3. 1956).

This series, named for the earliest described species of the group, *Aeschynomene viscidula* Michx., includes a few closely related species of the section *Ochopodium* Vog. The plants are disconcertingly similar in appearance, all prostrate to suberect herbaceous or suffrutescent perennials arising from woody roots. The leaves, flowers, and fruits are relatively small, the leaflets ranging from about 2 to 30 mm long, the flowers from 5 to 13 mm long, and the articles, or joints, of the loments from 2 to 5 mm in diameter. The stipules are attached at the base, and the calyx is campanulate with five subequal lobes, or teeth.

In general, characters of the fruit are the most useful for separating the taxa. The number of articles can be counted, the length of the stipe and the dimensions of the articles can be measured. The kind and degree of pubescence is distinctive in a few species. Unfortunately, there is some instability, especially in certain species, that casts suspicion on the genetic composition and presents difficulties in key construction.

Since full descriptions are not included in this paper, except for new taxa, the following rather detailed key is presented.

KEY TO SPECIES AND VARIETIES

Fruit (1-) 2- or 3- (rarely 4- or 5-) articulate and short-stipitate, the stipe commonly 1–4 mm long, scarcely extending beyond the calyx, or, in a few cases, 5–7 mm long; bracteoles usually about half as long as the calyx or longer.

Leaves 5–9-foliolate, the leaflets obovate to cuneate; articles of fruit (3-) 4–5.5 mm in diameter.

Articles densely white-tomentulose and usually also beset with glandular hairs, sometimes the terminal article glabrate, 3.5–4 mm in diameter; stipe of fruit 1–3 mm long, mostly contained within the calyx (southern United States to northern and eastern South America).....**1. Ae. viscidula**

Articles glabrous to moderately appressed-pubescent, (3-) 4–5.5 mm in diameter; stipe of fruit 2–7 mm long, usually extending 1–4 mm beyond the calyx.

Fruit with articles 4–5.5 mm in diameter, glabrous, the stipe 4–7 mm long; bracteoles about as long as the calyx (Mexico.....**2. Ae. acapulcensis**

Fruit with articles about 3–4 mm in diameter, appressed-pubescent to glabrate, the stipe 2–7 mm long; bracteoles about one-half as long as the calyx (South Africa; Madagascar; Mauritius; Réunion; eastern Australia)

3. Ae. brevifolia

Leaves 10–32-foliolate, the leaflets obovate to linear-oblong, occasionally some leaves with fewer leaflets; articles of fruit 2–3 (-5) mm in diameter.

Stipe of fruit 3–7 mm long, commonly hispidulous with hairs about 1 mm long.

Surface of articles crisp-pubescent to subglabrous and also best with glandular hairs; stipe 3–4 (-5) mm long; leaves mostly 10–20-foliolate, the leaflets obovate to oblong.

Fruit 2- or 3-articulate, rarely 4-articulate, the stipe 3–4 mm long; leaves predominantly 10–14-foliolate, the leaflets obovate or obovate-elliptic.

Flowers 5–8 mm. long; articles of fruit 2.5–3 mm long, 2–3 mm wide (widespread in tropical America)

4a. Ae. brasiliana var. **brasiliana**

Flowers about 10 mm long; articles of fruit 4–5 mm long, 3–4 mm wide (Upper Orinoco, Venezuela)

4b. Ae. brasiliana var. **carichanica**

Fruit 4- or 5-articulate, the stipe 4–5 mm long; leaves 14–20-foliolate, the leaflets oblong or obovate-oblong (northern Venezuela)

4c. Ae. brasiliana var. **venezolana**

Surface of articles crisp-puberulent to glabrate; stipe 5–7 mm long; leaves about 20–32-foliolate, the leaflets elliptic (Minas Gerais, Brazil) ..... **5. Ae. vogelii**

Stipe of fruit 1.5–3 mm long, hispid, the hairs 2–4 mm long, concentrated at base of the first article; surface of articles glabrous to moderately pubescent but lacking glandular hairs.

Articles of fruit 2–2.5 mm in diameter; flowers 4–7 mm long; leaflets entire, oblong-elliptic, rarely somewhat obovate.

Leaflets 4–6 (-8) mm long, 1.5–3 mm wide; stipules linear-lanceolate, about 1 mm wide at the base, 4–5 mm long; stems usually prostrate.

Fruit with articles glabrous to moderately crisp-puberulent; stems and leaves moderately pubescent or often glabrate (widespread in Central and South America)

6a. Ae. histrix var. **histrix**

Fruit with articles appressed-pubescent; stems and leaves canescent (Central and South America; one collection from Florida)

6b. Ae. histrix var. **incana**

Leaflets 7–12 mm long, 2–4 mm wide; stipules broadly lanceolate, usually 2–3 mm wide at the base, 5–15 mm long; stems suberect (Mexico to South America)

6c. Ae. histrix var. **densiflora**

Articles of fruit 2.5–3 mm in diameter; flowers 7–9 mm long; leaflets setiferous, ovate or linear-oblong, or sometimes entire and linear-oblong.

Leaflets 2–5 mm long, 1–2 mm wide, ovate to elliptic-oblong, each bearing one or more yellowish, bulbous-based, glandular setae (Paraguay; Missiones, Argentina)

6d. Ae. histrix var. **multijuga**

Leaflets 5–10 mm long, 1.5–2 mm wide, linear-oblong, entire of ciliate (Paraguay)

6e. Ae. histrix var. **apana**

Fruit 4–9-(infrequently fewer) articulate and long-stipitate, the stipe (4-) 5–15 mm long; bracteoles about 1 mm long, or one-third as long as the calyx.

Articles of fruit 2–2.5 mm in diameter; stipe commonly 10–15 mm long; leaves mostly 10–18-foliolate, the leaflets obovate or obovate elliptic (widespread in tropical America) ..... **7a. Ae. elegans** var. **elegans**

Articles of fruit 3–5 mm long, 2.5–4 mm wide. Leaves predominantly 9–32-foliolate.

Flowers 5–10 mm long; fruit with articles 3–4 mm long and 3 mm wide.

Leaflets obovate or obovate-elliptic; leaves 5–14-foliolate; stipe of fruit (4-) 5–8 mm long.

Fruit with articles 3–4 mm long and 3 mm wide; flowers 8–10 mm long; leaflets about 10–20 mm long, 5–10 mm wide (Goyaz, Brazil)

7b. Ae. elegans var. **robustior**

Fruit with articles about 3 mm in diameter; flowers 5–7 mm long; leaflets 3–10 mm long, 2–4 mm wide (coastal Brazil; Puerto Rico)

8. Ae. graci'is

Leaflets elliptic or oblong-elliptic, 5–15 mm long, 3–4 mm wide; leaves 16–20-foliolate; flowers 7–10 mm long; articles of fruit 3–4 mm long and 3 mm wide; stipe 7–10 mm long (southeastern Colombia; western Brazil)

9a. Ae. foliolosa

Flowers 10–15 mm long; fruit with articles about 5 mm long and 4 mm wide; leaflets elliptic or obovate-elliptic, 7–20 mm long, 5–10 mm wide (Rio de Janeiro, Brazil) ..... **10. Ae. bradei**

Leaves 5–8-foliolate.

Leaflets obovate or obovate-elliptic, obtuse, entire, 3–15 mm long, 2–6 mm wide.

Flowers 7–10 mm long; leaves not more than 8-foliolate; fruit usually 6–8-articulate, the stipe 6–14 mm long.

Fruit with articles about 3–4 mm long, 2.5–3.5 mm wide; flowers 7–9 mm long (widespread in tropical South America)

11a. Ae. falcata var. **falcata**

Fruit with articles 4–5 mm long and 3–4 mm wide; flowers 8–10 mm long (Paraguay)

11b. Ae. falcata var. **hassleri**

Flowers 5–7 mm long; leaves 5–12-foliolate; fruit (3-) 4–7-articulate, the stipe (4-) 5–8 mm long (costal Brazil; Puerto Rico) ..... **8. Ae. gracilis**

Leaflets elliptic-oblong, acute, 12–30 mm long, 5–10 mm wide, the margins closely ciliate; fruit 3- or 4-articulate, the stipe about 5–7 mm long, the articles about 3 mm in diameter (Minas Gerais, Brazil)

12. Ae. warmingii

1. **Aeschynomene viscidula** Michx. Fl. Bor. Am. **2**: 74. 1803, non Roxb. ex Willd. 1809.
Aeschynomene prostrata Poir. in Lam. Encyc. Suppl. **4**: 76. 1816.
Secula viscidula (Michx.) Small, Fl. Miami 90, 200. 1913.
Aeschynomene eriocarpa Standl. & Steyerm. Field Mus. Publ. Bot. **23**: 9. 1943.

This species is easily recognized by its short-stipitate, densely tomentulose fruits. Even though geographically widespread, the morphological characters are generally uniform in all the material observed. The chief instability appears to be in the fruit indument; the glandular hairs may fail to develop, or sometimes the terminal one or two joints of the loments may be glabrous.

2. **Aeschynomene acapulcensis** Rose, Contr. U.S. Nat. Herb. **5**: 191. 1899.
Aeschynomene picachensis Brandeg. Univ. California Publ. Bot. **6**: 181. 1915.

On the basis of the fruit characters indicated in the key, this glabrous-fruited Mexican species has been retained as separate from the pubescent-fruited *Ae. brevifolia* which occurs in the Old World. It is my strong feeling, however, that the two taxa might ultimately be proved conspecific. The geographic separation could be explainable in terms of early sailing routes and the practice of transporting animals and fodder, but the evidence is scanty. Thus far I have seen only three collections from Mexico and but slightly more material from Africa, Madagascar, and the other known localities for *Ae. brevifolia*.

Vegetatively, the plants of *Ae. acapulcensis* and *Ae. brevifolia* are virtually indistinguishable. They may range from glabrous to pubescent, and there is considerable variation in stipe length of the fruit, even on individual specimens.

3. **Aeschynomene brevifolia** L. ex Poir. in Lam. Encyc. **4**: 451. 1797.
Hedysarum micranthos Poir. in Lam. Encyc. **6**: 446. 1806.
Aeschynomene micrantha (Poir.) DC. Prodr. **2**: 321. 1825.
Patagonium racemosum E. Mey. Comm. Pl. Afr. Austr. **1**: 123. 1835.

As already indicated in the key and in the comments under the preceding species, *Ae. brevifolia*, based on a collection from Madagascar, is scarcely distinguishable from *Ae. acapulcensis* from Mexico. Except for differences in fruit indument, some of the specimens with glabrate leaflets and fruits, from Madagascar and Réunion, for example, are quite similar to material of the type collection of *Ae. acapulcensis*. Other specimens with more glandular development, such as most from South Africa, vegetatively resemble the type collection of *Ae. picachensis*, which I consider referable to *Ae. acapulcensis*.

I have seen a sheet from L that I presume to be an isotype of *Patagonium racemosum* E. Mey. collected by Drege in Africa. It is essentially identical with other collections of *Ae. brevifolia* from Africa.

The collections from Australia seem to belong to this species but approach *Ae. gracilis* in longer leaf axis, and *Ae. falcata* in fruit characters, having longer stipes and sometimes four or five articles instead of the customary two or three. The bracteoles are slightly shorter than average. Bentham (Fl. Austral. **2**: 227. 1864) considered this material as "quite identical" with *Ae. falcata* var. *paucijuga* from Brazil, and cited *Ae. micrantha* as a synonym.

There has been a question as to the correct name for this taxon. Apparently Poiret validated the Linnaean name *Ae. brevifolia*, based on a collection by Commerson in Madagascar, and then, later, published *Hedysarum micranthos* based on material of presumably the same collection. I have not yet learned the circumstances of Linnaeus's connection with the Commerson collection, nor has a sheet been located with "*brevifolia*" in Poiret's handwriting.

From P I have seen isotypes of *H. micranthos* and a photographic negative of the type. One sheet with Commerson's handwriting attests to the authenticity of the collector's name and locality. The type and one of the isotypes have been annotated by Poiret as *Hedysarum micranthos*. On two other sheets, including one from Desvaux's herbarium, are the three names, *Hedysarum micranthos*, *Aeschynomene micrantha*, and *Aeschynomene brevifolia*. It would appear that Desvaux's interpretation of the three names as synonymous would be correct and that the name *Ae. brevifolia* should have priority.

Unfortunately, the sheet in the Lamarck herbarium, labeled as the type of *Ae. brevifolia*, appears to be incorrect. A fragment of ample size for determination, lent me from P, is identical with type material of *Hedysarum falcatum*, based on a Commerson collection in Brazil. There must have been an error in labeling this particular sheet.

There are additional labels on this putative, but apparently erroneous, type sheet. Annota-

tions "du bresil," "de Commerson," and "Aeschinomene brevifolia. Dict. No. 10" are in Lamarck's hand. Desvaux added the names "hedysarum falcatum Poir. enc. en Desv." That Desvaux recognized a confused situation is indicated by other labels, "hedysarum micranthos Poir. enc. en Desv." and "Ces deux plantes etoient sous un seul nom dans cet herbier *Aesch. brevifolia* mais j'ai la certitude que la *brevifolia* est l'hedys. micranthus du meme auteur et que l'autre qui n'est pas de Madagascar mais du brésil est l'hedys. falcatum Poiret."

I am greatly indebted to Dr. Alicia Lourteig for doing considerable research for me in locating the pertinent specimens, transcribing certain labels, and photographing types that could not be lent.

4a. **Aeschynomene brasiliana** (Poir.) DC. var. **brasiliana.**

Aeschynomene brasiliana (Poir.) DC. Prodr. **2**: 322. 1825.
Cassia biflora Mill. Gard. Dict. ed. 8, no. 14. 1768, non L. 1753.
Hedysarum brasilianum Poir. in Lam. Encycl. **6**: 448. 1804.
Cassia houstoniana Collad. Hist. Nat. Med. Cass. 132. 1816.
Aeschynomene paucijuga DC. Prodr. **2**: 321. 1825.
Aeschynomene paucijuga var. *subscabra* DC. Prodr. **2**: 321. 1825.
Hedysarum hirtum Vell. Fl. Flum. 319. 1825; Icon. **7**: tab. 151. 1835.
Aeschynomene brasiliana β Vog. Linnaea **12**: 90. 1838.
Aeschynomene biflora (Mill.) Fawc. & Rendle, Fl. Jam. **4**: 27. 1920.
Aeschynomene guaricana Pittier, Bol. Tecn. Minist. Agric. & Cría, Serv. Bot. Caracas **5**: 41. 1944, without Latin diagosis.

This widely distributed species is readily identifiable by the fruit, flower, and leaf characters given in the key. The material is generally uniform, with minor variation in size of vegetative parts due, probably, to habitat factors. A few specimens show reduction in fruit indument. What appear to be more significant variations are indicated in the following two taxonomic varieties.

4b. **Aeschynomene brasiliana** (Poir.) DC. var. **carichanica** Rudd, var. nov.

A varietate typica floribus fructibusque majoribus differt.

The plants are more robust and the flowers and fruits significantly larger than those of the typical variety, the flowers about 10 mm long, the articles of the fruit 4–5 mm long and 3–4 mm wide.

Type in the U.S. National Herbarium, no. 2167562, collected on the north end of Cerro Carichana (Cerro Gavilan), elevation 100–300 m, December 21, 1955, by J. J. Wurdack and J. V. Monachino (no. 40885). Duplicates at NY and VEN.

4c. **Aeschynomene brasiliana** (Poir.) DC. var. **venezolana** Rudd, Contr. U.S. Nat. Herb. **32**: 80. 1955.

This variety, known only from northern Venezuela, differs from the typical variety in leaf and fruit characters, the leaves consistently narrower and the fruits with longer stipes and more numerous articles.

5. **Aeschynomene vogelii** Rudd, nom. et stat. nov.

Aeschynomene podocarpa var. β Vog. Linnaea **12**: 89. 1838.
Aeschynomene falcata var. γ *multijuga* Benth. in Mart. Fl. Bras. **15**(1): 68. 1859.

This taxon appears to warrant specific status, and designation of a new name is necessary. The epithet *vogelii* is chosen in honor of Dr. J. R. Theodor Vogel, the author of many of the taxa of this series, including the variety on which this species is based.

In my earlier paper I treated *Ae. podocarpa* and its var. β as synonymous. Since then I have had the privilege of examining additional specimens and have concluded that the fragment at F, labeled as *Aeschynomene podocarpa*, must be a portion of the Sellow collection on which var. β was based, rather than typical *Ae. podocarpa*. The identity of typical *Ae. podocarpa* is problematic, but I now believe that it is referable to *Ae. elegans*.

Bentham based his *Ae. falcata* var. γ *multijuga* on *Ae. podocarpa* var. β and cited two Brazilian collections. One, the type, is the Sellow collection from Serra Itambé, Minas Gerais, and is the basis of my *Ae. vogelii*. The other, collected by Weddell "in arenosis maritimis Rio de Janeiro," is represented by a sheet at P, annotated in what appears to be Bentham's hand, but it actually is *Ae. elegans* and is quite unlike the Sellow collection.

There are two additional collections from Minas Gerais that seem to belong to this taxon: *Riedel* 943, from Serra de Lapa (NY), and *Markgraf, Mello Barreto, & Brade* 3455, from Serra do Grão Mogol (RB; US, fragment). The

material is essentially like the specimens of the Sellow collection except that the leaflets average a little smaller in size and exhibit more glandular development, with the margins mostly glandular-denticulate.

6a. **Aeschynomene histrix** Poir. var. **histrix.**
Aeschynomene histrix Poir. in Lam. Encyc. Suppl. **4**: 77. 1816.
? *Aeschynomene cassioides* Desv. in Ham. Prod. Pl. Ind. Occ. 51. 1825.
? *Aeschynomene echinus* Vog. Linnaea **12**: 92. 1838.
Aeschynomene conferta Benth. Ann. Nat. Hist. **3**: 433. 1839.
Aeschynomene mucronulata Benth. Hook. Journ. Bot. **2**: 56. 1840.
Aeschynomene histrix var. *mucronulata* Benth. in Mart. Fl. Bras. **15**(1): 69. 1859.
Secula hystrix (Poir.) Small, Man. Southeast Fl. 728. 1933.
Aeschynomene pineticola Standl. & Wms. Ceiba. **1**: 79. 1950.

This species *sensu latior* is polymorphic and fairly widespread in Tropical America. The principal variations are indicated in the key.

In this paper I am following Bentham who assigned *Ae. echinus* to *Ae. histrix* "ex descr." Although I am tentatively placing *Ae. echinus* under the typical variety of *Ae. histrix*, it is possible that it is the same as *Ae. histrix* var. *densiflora*. The specimens that I previously determined as *Ae. echinus* are referred in this paper to two other varieties of *Ae. histrix*, var. *apana*, and var. *multijuga*.

Presumably Vogel in his examination of the Sellow specimens from Brazil made few comparisons with specimens from beyond that country's borders. He must have disregarded *Ae. histrix* from French Guiana (*Ae. densiflora* from British Guiana was not yet published) and initiated the new species *Ae. echinus*. In his description of *Ae. echinus* he states that the stipules, racemes, and flowers are as in the preceding species, which is his *Ae. incana*, another variety of *Ae. histrix*, according to the present treatment.

6b. **Aeschynomene histrix** Poir. var. **incana** (Vog.) Benth. in Mart. Fl. Bras. **15**(1): 69. 1859 (As *Ae. hystrix* var. *incana*).
Aeschynomene puberula DC. Prodr. **2**: 321. 1825.
Aeschynomene incana Vog. Linnaea **12**: 90. 1838, non G. F. W. Mey. ex DC. 1825, as synonym.

As indicated in the key, var. *incana* is very similar to the typical variety, differing chiefly in indument.

6c. **Aeschynomene histrix** Poir. var. **densiflora** (Benth.) Rudd, Contr. U.S. Nat. Herb. **32**: 84. 1955.
Aeschynomene densiflora Benth. in Hook. Journ. Bot. **2**: 56. 1840.

Although there is intergradation between varieties of *Ae. histrix*, the specimens of var. *densiflora* usually are readily distinguished, especially from those of the typical variety, by their robust habit, and larger leaflets and stipules.

6d. **Aeschynomene histrix** Poir. var. **multijuga** (Chod. & Hass.) Rudd, comb. et stat. nov.
Aeschynomene brasiliana (Poir.) DC. forma *multijuga* Chod. & Hass. Bull. Herb. Boiss. II. **4**: 882. 1904.

This taxon, originally published as a form of *Ae. brasiliana*, has the principal characteristics, especially the dolabriform fruit structure, of *Ae. histrix*. It differs from typical *Ae. histrix* in having slightly larger flowers and fruits, and leaflets that are mostly denticulate with bulbous-based glandular setae.

Specimens of the type collection of this variety indicate a rather luxuriant, suffrutescent herb, 0.5–1.5 m tall. It was collected by Hassler (No. 5814) "in campo pr. flumen Carimbatay," Paraguay. I have seen isotypes from GH, MO, and NY.

The three other collections that I am assigning to this variety are from Missiones, Argentina, as follows: "On the Parana 26°–27° S. Lat.," *Parodi* 100 (K); Loreto, *Ekman* 1720 (NY); San Ignacio, *Burkart* 15344 (US). They apparently are from lower, more compact plants, with shorter internodes and slightly smaller leaflets. In the character of the fruits, flowers, and glandular setae, however, they appear to be essentially the same as specimens of the type collection.

In my earlier paper I interpreted this material as representing *Ae. echinus*. While the exact identity of *Ae. echinus* is still in doubt, I now think that it is more likely to be the same as typical *Ae. histrix*, or possibly *Ae. histrix* var. *densiflora*. The type locality of *Ae. echinus* also is not exactly known but on the basis of what is known of Sellow's itinerary, presumably it is from farther south or east than the above cited specimens. So far I have seen nothing like var. *multijuga* from the range of Sellow's travels.

6e. **Aeschynomene histrix** Poir. var. **apana** Rudd, var. nov.

A varietate typica foliolis elongatis, floribus fructibusque majoribus differt.

The specimens of this variety, because of the linear-oblong leaflets, 5–10 mm 1.5-2 mm wide, have an aspect quite different from others of *Ae. histrix*, yet the flowers and fruits are all essentially the same. Occasional leaflets of var. *apana* have a few marginal glandular setae such as are found in var. *multijuga*.

Type in the U. S. National Herbarium, no. 1177243, collected near the Río Apa, at Centurión, Paraguay, December 9, 1908, by K. Fiebrig (no. 4387). Duplicate at GH. Additional material is the Hassler collection no. 11021 (F, GH,NY,US), also from near the Río Apa, Paraguay.

7a. **Aeschynomene elegans** Schl. & Cham. var. **elegans.**

Aeschynomene elegans Schl. & Cham. Linnaea **5**: 583. 1830.
Aeschynomene tecta Vog. Linnaea **12**: 87. 1838.
Aeschynomene falcata Vog. var. *plurijuga* Benth. in Mart. Fl. Bras. **15**(1): 68. 1859.
Aeschynomene falcata Vog. var. *elegans* (Schl. & Cham.) O. Ktze. Rev. Gen. **1**: 158. 1891.
Aeschynomene falcata Vog. var. *elegans* (Schl. & Cham.) O. Ktze. forma *glabrior* O. Ktze. Rev. Gen. **1**: 158. 1891.
Aeschynomene arenicola Brandeg. Univ. California Publ. Bot. **10**: 408. 1924.

This species is easily recognized by its slender, long-stipitate, small-jointed, moniliform fruits. It is one of the most widespread of the series, ranging from Mexico to southern Brazil.

Many of the collections annotated and cited by Bentham as *Ae. falcata* actually are specimens of *Ae. elegans*. His *Ae. falcata* var. *plurijuga*, based on *Ae. tecta* and *Ae. podocarpa*, certainly must be the same as *Ae. elegans*. Sellow specimens from Brazil annotated as *Ae. tecta*, presumably isotypes, are *Ae. elegans*.

The identity of typical *Ae. podocarpa* still is in question. I have seen no Sellow specimens annotated as such or any that I can relate to the original description.

Previously, on the basis of characters in the original description and examination of a small photographic negative of type material, I decided that *Ae. gracilis* should be placed in synonymy under *Ae. elegans*. I have now seen isotypes of *Ae. gracilis* and conclude that it should be reinstated as a distinct species.

7b. **Aeschynomene elegans** Schl. & Cham. var. **robustior** Rudd, var. nov.

A varietate typica foliolis fructibusque majoribus differt.

As characterized in the key, this more robust variety of *Ae. elegans* is recognized by its relatively larger leaves with 10–14 leaflets, 10–20 mm long and 5–10 mm wide, and fruit with larger articles, 3–4 mm long and 3 mm wide. The fruit stipe is about 5–8 mm long, in contrast to the 10–15 mm long stipe that is customary in typical *Ae. elegans*.

Type in the Herbarium of the Royal Botanic Gardens, Kew, collected at Brejon, near Santa Cruz, Goyaz, Brazil, by J. E. Pohl, in 1820.

There are two other sheets at K that appear to belong to the same collection, labeled no. 1101, but without collector's name.

8. **Aeschynomene gracilis** Vog. Linnaea **12**: 89. 1838, non Miq. 1844.

Aeschynomene portoricensis Urb. Symb. Antill. **1**: 325. 1899.

After examining isotypes of *Ae. gracilis* from Brazil and *Ae. portoricensis* from Puerto Rico, it seems appropriate to combine the two species. Their close similarity was mentioned by Urban in connection with his publication of *Ae. portoricensis*. The former species is known only from the type collection by Sellow in Brazil between Campos, Rio de Janeiro, and Victoria, in Espirito Santo. The latter species, which has been frequently collected in Puerto Rico, is somewhat variable as to leaf size, number of articles per fruit, and stipe length, but several specimens are essentially identical with the Sellow collection from Brazil.

There is some similarity to *Ae. falcata* in fruit characters but the stipe of *Ae. gracilis* is usually shorter and the loments have fewer, obliquely semioval joints. The flowers are smaller. The leaves seem to be intermediate between *Ae. elegans* and *Ae. micrantha*.

9. **Aeschynomene foliolosa** Rudd, Contr. U.S. Nat. Herb. **32**: 91. 1955.

This is a distinctive species with panicles of small flowers and slender long-stipitate fruits. The leaves are relatively long with 16–20 oblong-elliptic leaflets.

In the original description only two localities are cited, both from the outer periphery of the Amazon Basin. Recently another collection from a somewhat intermediate area has been recog-

nized, *Ducke* [Herb. No.] 12382 (MG), collected December 14, 1912, at Campo da Frequezia Velha, Coary, Brazil.

10. **Aeschynomene bradei** Rudd, sp. nov. Fig. 1

Suffrutex diffusus, ad sectionem *Ochopodium* pertinet, foliis 3–5 cm longis, 9–16-foliolatis, foliolis ellipticis, adpresse pubescentibus; *Ae. elegans* var. *robustior* affinis sed imprimis floribus fructibusque majoribus differt.

Stems suffrutescent, rusty-tomentose when young, somewhat glandular-hispidulous, glabrescent; stipules lanceolate or lanceolate-ovate, about 5–8 mm long, attenuate, 1–2 mm broad at the base, pubescent like the stem; leaves about 3–5 cm long, 9–16-foliolate; leaflets elliptic or obovate-elliptic, 7–20 mm long, 5–10 mm broad, obtuse, mucronulate, entire, moderately appressed-pubscent on both surfaces, the hairs colorless or sometimes rusty; inflorescences axillary, racemose, slightly longer than the subtending leaves; bracts deltoid-ovate, about 1 mm in diameter, pubescent, the bracteoles ovate, about 2 mm long and 1 mm wide; flowers yellow, 10–15 mm long; calyx 3–5 mm long campanulate with 5 subequal lobes about 2 mm long, ciliate, subglabrous to glandular-hispidulous; standard 10–15 mm long, the claw 2–3 mm long, the blade suborbicular, 8–10 mm in diameter, pubescent on the outer face; wings and keel slightly shorter than the standard, the wing blades oblique, 4–5 mm broad, the keel blades about 2 mm broad, bent at about a 90° angle; stamens 8–12 mm long, monadelphous, the filaments united from base to midlength, the sheath open on the carinal side; ovary 5-ovulate, pubescent; fruit 2–5-articulate, the stipe subglabrous, 7–10 mm long, the articles crisp-pubescent, about 5 mm long and 4 mm wide; seed brownish black, sublustrous, 3 mm long, 2 mm broad, and compressed to 1 mm or less in thickness.

Type in the herbarium of the Jardim Botanico do Rio de Janeiro, no. 28707, collected at Pedra Dubois, Santa Maria Madalena, Rio de Janeiro, Brazil, altitude 1,100 m. February 27, 1935, by Santos Lima and A. C. Brade (no. 14220). Fragment and photograph at US.

Only one other specimen is known, a unicate at RB, collected at Pedra das Flores, Santa Maria Madalena, Rio de Janeiro, Brazil, altitude 1,200 m, March 4, 1934, by Santos Lima and A. C. Brade (no. 13273). Fragment at US

FIG. 1.—*Aeschynomene bradei: a*, Portion of stem with leaf, immature flower, and fruit (nat. size); *b*, standard; *c*, wing; *d*, keel; *e*, calyx and stamen filaments; *f*, one article of fruit, open, showing seed. (*b–f*, ×2.)

This species, represented by the two collections cited above, is readily referable to series *Viscidulae* of section *Ochopodium*. In general structure it resembles such related species as *Aeschynomene falcata*, *Ae. elegans*, *Ae. vogelii*, and *Ae. foliolosa*. In aspect it is rather distinctive due to more robust, woody growth, larger flowers and fruits. The critical characters are indicated in the key.

11a. **Aeschynomene falcata** (Poir.) DC. var. **falcata.**

Aeschynomene falcata (Poir.) DC. Prodr. **2:** 322. 1825.

Hedysarum falcatum Poir. in Lam. Encyc. Meth. Bot. **6:** 448. 1804.

Hedysarum diffusum Vell. Fl. Flum. Text 320. 1825; Icon. **7:** pl. 155. 1835.

Aeschynomene falcata (Poir.) DC. var. *paucijuga* Benth. in Mart. Fl. Bras. **15**(1): 67. 1859.

Aeschynomene apoloana Rusby, Bull. New York Bot. Gard. **6:** 511. 1910.

An isotype and a photographic negative of the type of *Hedysarum falcatum* Poir., on which *Ae. falcata* is based, have recently been sent to me from Paris. This authentic material, in the Jussieu Herbarium, was collected by Commerson in Brazil. It has characteristic falcate fruit and 5–8-foliolate leaves, and confirms our concept of the species.

As explained under *Ae. brevifolia*, material from a sheet in the Lamarck Herbarium and labeled as the type of *Aeschynomene brevifolia* L. ex Poiret, appears to be identical with the type material of *H. falcatum*. According to the description, *Ae. brevifolia* was collected by Commerson in Madagascar. There must have been

an error in labeling the collection, however, as this specimen does not fit the description of *Ae. brevifolia*, and must really be a duplicate of Commerson's Brazilian collection of *Hedysarum falcatum*.

11b. **Aeschynomene falcata** (Poir.) DC. var. **hassleri** Rudd, var. nov.

A varietate typica foliolis fructibus floribusque majoribus differt.

In comparison with material of typical *Ae. falcata*, the specimens of this variety are outstanding in appearance due to more vigorous growth, especially their larger flowers, fruits, and leaves. The differences apparently are in degree rather than structural pattern.

This is another example of specimens from Paraguay being significantly more robust and with larger organs than their closest relatives.

Type in the Herbarium of the Royal Botanic Gardens, Kew, collected in a thicket near Concepción, Paraguay, September 1901, by E. Hassler (no. 7461). Isotype at NY.

There is an additional sheet at K, also collected by Hassler (no. 10977), "In altaplanitie, Sierra de Amambay," Paraguay, 1913.

12. **Aeschynomene warmingii** Micheli, Vid. Medd. Nat. Foren. Kjøbenhavn 68. 1875.

As indicated in the key, this species from Lagoa Santa, Minas Gerais, Brazil, is distinctive with its fairly large, 5–7-foliolate leaves. Unfortunately, it is known only from the type collection.

INSECTS AS FLYERS

Insects are the most efficient flying animals. They surpass both birds and bats. They are superior in some ways to any "flying machine" yet invented by man. The air was their exclusive domain for at least 100 million years before any rival winged creatures appeared. During this time they developed two flight systems, direct and indirect, which are in use today, although the former is confined to a few groups such as the dragonflies.

This is the claim of Dr. R. E. Snodgrass, research associate of the Smithsonian Institution, in a report on arthropod evolution recently published by the Institution. The earliest known insects, with highly developed jumping mechanisms, were wingless. There are some wingless forms today. But, Dr. Snodgrass points out, the earliest known winged insects in the fossil record had the flying mechanism fully developed so that its evolutionary development largely is a matter of conjecture.

The first step, as deduced by Dr. Snodgrass, was the emergence from the sea of some long extinct many-footed wormlike creature. The feet were fleshy lobes by means of which it had moved clumsily along the sea bottom. A first evolutionary step was the elimination of these lobes on all but the first three segments of the body behind the head. These gradually evolved into legs.

The earliest insects, Dr. Snodgrass says, to come on land presumably were provided with so-called "paranotal lobes," small appendages attached to the back in the region of the thorax. These are not hypothetical structures which since have disappeared, he says, since there are traces of them in various modern insects and in others; during the nymph stage, wings first appear as lobelike extensions from the back.

"Presumably," says Dr. Snodgrass, "when these paranotal lobes became sufficiently large in the primitive insects they first served as gliders. If the at first rigid lobes became flexible at their bases they could then, by action of the thoracic muscles, be flapped up and down, thus enabling the gliding insect to sustain itself longer in the air. Even this simple wing movement, however, involved modifications of the thoracic skeleton and some degree of adaptation in the musculature."

Eventually, he points out, the back muscles became differentiated to the point where they could move the wings without the help of any wing muscles per se. This is the "indirect" system of most insects.

Development of wings was evidently a response to demand. The first winged insects appear very shortly after the appearance of the first tall plants in the primeval swamps.

The direct up-and-down movement, with various modifications, continues in the "direct flight" system, best exemplified by the dragonflies.

During the long period of their undisputed domain of the air both systems developed. Then came the birds and bats to dispute their aerial supremacy. They fed chiefly on insects whose only defense was the development of greater speed and flying accuracy.

As a result the less efficient systems tended to become eliminated and the present methods of insect flight better developed.

NEWS OF MEMBERS

Dr. Bernard Frank is the new forestry officer, Forest Research Institute, Dehra Dun, Uttar Pradesh, India.

Mr. Thomas G. Digges has been honored with the first annual George Kimball Burgess Memorial Award of the Washington Chapter of the American Society for Metals.

Mr. Conrad V. Morton, curator of the division of ferns, U. S. National Museum, Smithsonian Institution, is one of two American botanists who have been awarded honorary life memberships in the American Gesneria Society for their important contributions to the world's knowledge of the plant family Gesneriaceae, which includes the African violet and gloxinia.

To understand Nature we must first study man thoroughly, because there is nothing in the universe which is not to some degree hidden in man's nature. Man is verily a universe in miniature.—PLINY THE ELDER.

ZOOLOGY.—*A review of the gorgonacean genus* Placogorgia *Studer, with a description of* Placogorgia tribuloides, *a new species from the Straits of Florida.*

FREDERICK M. BAYER, U. S. National Museum.

(Received December 5, 1958)

The extensive dredging operations of the U.S. Fish Commission steamer *Albatross* brought to light a great many zoological novelties, not a few of which are still awaiting description. Among these is a new gorgonian coral of the genus *Placogorgia*, which is now described and figured.

The genus *Placogorgia* as presently constituted contains four species in the Atlantic Ocean. All are characterized by calicular thorn-scales with a rather broad, branched, basal root and a stout, more or less laciniated but usually blunt spine, which projects above the surface of the calicles, giving them a thorny appearance. Although the thorn-scales of the four species are not identical, they are so similar that only exhaustive descriptions could point out the differences between them, and the species are distinguished mainly upon differences in the size and ornamentation of the cortical spindles.

The new species of *Placogorgia* that is the subject of this paper differs rather strikingly from the four previously known Atlantic species in the huge size of its calicular thorn-scales, which, moreover, have a quite acute spine and therefore bear a strong resemblance to the thorn-scales of *Paramuricea*. In this study, it has been necessary to reexamine all the Atlantic species of *Placogorgia* and to reappraise their position in respect to *Paramuricea* and related genera with calicular thorn-scales.

Genus **Placogorgia** Studer

Placogorgia Studer, 1887, Arch. Naturg. **53**(1): 56. [No species described.]

Placogorgia Wright and Studer, 1889, *Challenger* Zool **31** (part 64): 113. (Type species, *Placogorgia atlantica* Wright and Studer, fixed by subsequent monotypy.)

not *Placogorgia* Nutting 1910, *Siboga* Exped. Monogr. **13b**: 76. [= *Discogorgia* Kükenthal.]

Placogorgia Nutting, 1912, Proc. U.S. Nat. Mus. **43**: 83.

Pseudothesea Kükenthal, 1919, Ergebn. deutschen Tiefsee-Exped. **13**(2): 843. (Type species, *Thesea placoderma* Nutting, by original designation.)

As described, *Placogorgia* is difficult to separate from *Paramuricea* and *Echinomuricea*. Most of the species of *Placogorgia*, including some from the Indo-Pacific assigned to *Thesea* by Nutting (= *Pseudothesea* Kükenthal), have large, rude spindles that often become platelike, with strong external spines, and small, rather blunt calicular thorn-scales. *Paramuricea* has large, sharp thorn-scales (sometimes with the basal part much reduced), and small spindles usually without external spines—rarely flat scales with a central projecting process or boss. Unfortunately, the type species of *Placogorgia* has small cortical spindles with little or no indication of external spines, and rather sharp, but small, calicular thorn-scales (both characters like *Paramuricea*); and *Paracuricea multispina* Deichmann has cortical plates with a projecting process, and blunt calicular thorn-scales (characters approaching *Placogorgia*). Except for *E. atlantica*, *Echinomuricea* has stellate thorn-scales with a smooth or nearly smooth spine; its distribution is primarily Indo-Pacific. I am inclined to think that the *Echinomuricea atlantica* described and figured by Thomson (1927, p. 40, pl. 4, fig. 3) is actually Johnson's *Acanthogorgia grayi* (Johnson 1862, p. 195) rather than *atlantica*—compare the spicules!—and that it belongs to *Placogorgia* and not to *Echinomuricea* or *Paramuricea*. Its calicular thorn-scales and cortical plates are similar to those of the new *Placogorgia* described herein, but Thomson gives no measurements and the magnification of his figures is not indicated, so its identity remains uncertain. Kükenthal (1924, pp. 225–226) suggested that both *atlantica* and *grayi* are referable to *Paramuricea*. This disposition is contraindicated in the case of *grayi* (Thomson's *atlantica*) by the large plates with several projecting spines, but could be valid for the true *atlantica*. There seem to be no species in the Atlantic Ocean that can be assigned to the genus

Echinomuricea as defined by most authors, which is characterized by calicular thorn-scales of a particularly distinct type.

Nutting (1910) described a number of East Indian species under the generic name *Placogorgia*, but most of them have been referred to other genera, notably *Discogorgia* (Kükenthal 1924, p. 212). He also described some muriceids with calicular thorn-scales and large, spinose cortical spindles and plates, which he placed in *Thesea*. Since they had nothing to do with the original *Thesea* of Duchassaing and Michelotti, Kükenthal in 1919 established for them the genus *Pseudothesea*, with *Thesea placoderma* Nutting as its type species. The character of its calicular thorn-scales leaves no doubt that *T. placoderma* is congeneric with *Placogorgia atlantica* Wright and Studer, and its cortical plates are not unlike those of *Placogorgia rudis* Deichmann. Most, perhaps all, of the other species described by Nutting in his monograph of the *Siboga* Muriceidae belong to other genera. *Thesea sanguinea* and *T. simplex*, of which I have seen type material, are referable because of their thorn-scales (which are of the "leaf-club" type) to *Echinogorgia*, a genus which perhaps should be ranked among the Plexauridae (Bayer, 1958, pp. 43, 48).

The paramuriceid species characterized by thorn-scales in the calicle are a closely interrelated complex, within which the generic distinctions—if such exist—must be drawn upon highly arbitrary grounds, at least until detailed studies can be made upon all pertinent type specimens. Until adequate studies can be undertaken there is no alternative but to recognize at least the most distinct of the genera that have been established. These genera are based mostly upon the form of the calicular thorn-scales. The thorn-scales of some genera, such as *Villogorgia*, *Trachymuricea*, and *Echinogorgia* (which possibly belongs in quite another family), are very distinctive, whereas those of other genera are only modifications of a simple, basic type, between which it is almost impossible to draw hard and fast boundaries.

The accompanying chart (Fig. 1) shows the major types and varieties of calicular thorn-scales (A–G) and cortical sclerites (H–N) found in the genera of Paramuriceidae sensu lato. (Excluded are *Bebryce* and *Acanthacis*, which are so distinctive that they need not enter into the present discussion.) The combinations of these types that occur in the various genera are indicated by the numbered connecting lines.

CALICULAR THORN-SCALES

A. The *Menella*-type (genus *Menella* Gray: Kükenthal, 1924, p. 184).—A single smooth, tapered spine rises from a root-part consisting of irregularly diverging branches. So far as I can tell from the literature, this type is always associated with cortical spindles that may produce strong external spines (J). I have seen only *Menella rubescens* Nutting, whose thorn-scales are illustrated (A); final definition of the genus will depend upon a reexamination of the type species, *M. indica* Gray, the holotype of which must be in the British Museum of Natural History.

B. The *Echinomuricea*-type (genus *Echinomuricea* Verrill: Kükenthal, 1924, p. 185).—A single smooth, tapered spine originates abruptly from a root-part consisting of four or five widely diverging branches, the whole producing a stellate body. These are usually, if not always, combined with simple, symmetrically sculptured spindles in the cortex (K). Similar thorn-scales, but with shorter projecting spine, are found in the genus *Eubrandella*, established by Deichmann (1936, p. 128) to replace Verrill's *Lissogorgia*, which was based on a single specimen said to have come from Florida; nothing like it has ever again been found in Florida, suggesting that it may have originated elsewhere—most likely in the Indo-Pacific. It resembles some of the species of *Echinomuricea* from that region.

C. The *Paramuricea*-type (genera *Paramuricea* Kölliker and *Placogorgia* Studer: Deichmann, 1936, pp. 134, 141).—Large thornscales with a stout, acute, more or less aculeate spike arising from a complicated, branched or lobed basal root. In combination with very large spindles and plates with (I) or without (H) spines, it is found in *Placogorgia japonica* (6) and *P. tribuloides* (3); with smaller spindles, sometimes knee-bent, it occurs in *Paramuricea placomus* (7).

D. The *Villogorgia*-type (genus *Villogorgia* Duchassaing and Michelotti, including *Acamptogorgia* Wright and Studer, *Brandella* Gray, *Paracamptogorgia* Kükenthal, and *Perisceles* Studer, all synonyms: Aurivillius, 1931, p. 204).—A projecting part that consists of a cluster of fingerlike processes, or thin radiating folia, arises

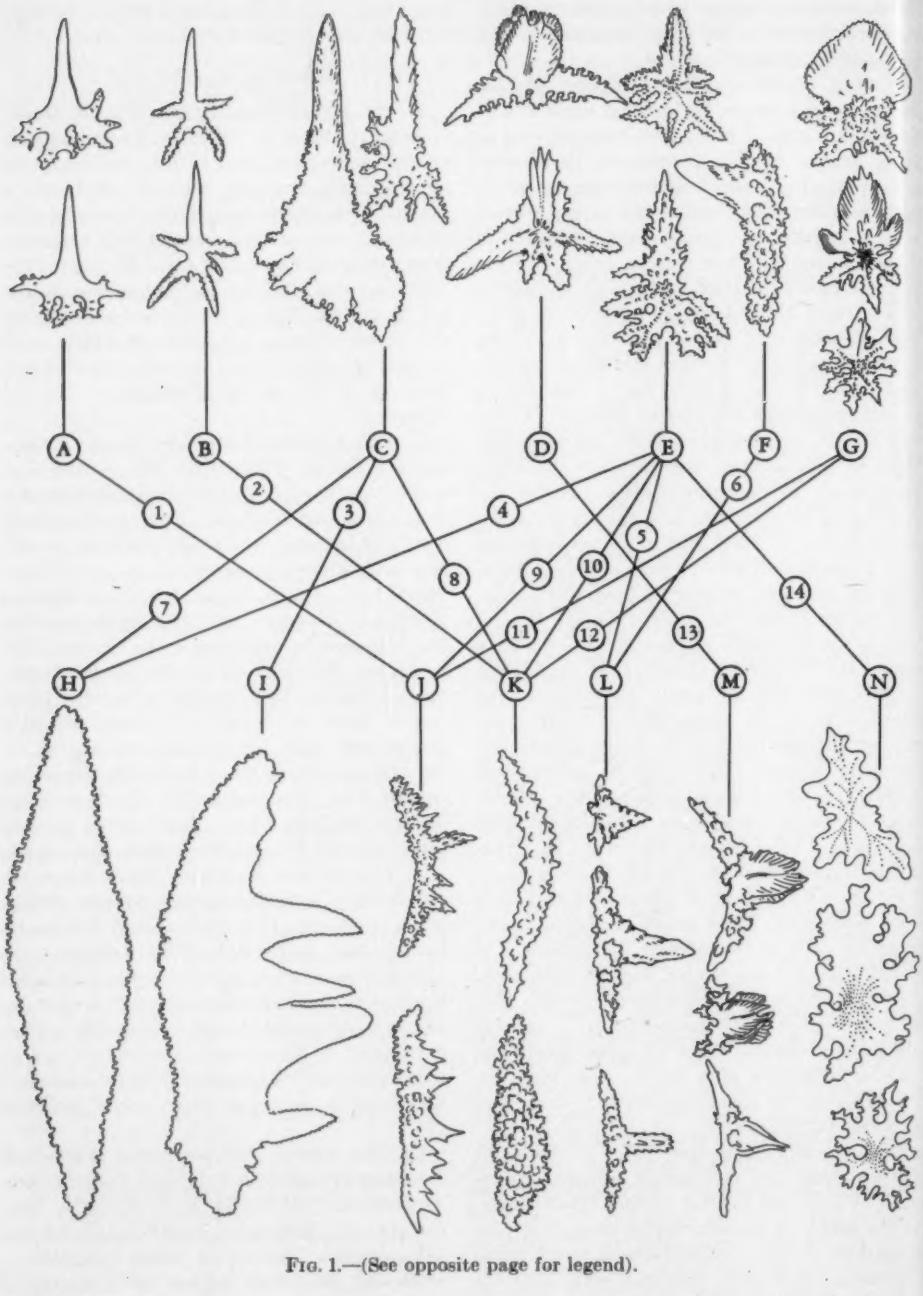


FIG. 1.—(See opposite page for legend).

from a widely diverging pair of flattened roots curved to fit the calicular walls. The various modifications that prompted the establishment of several genera were shown by Aurivillius (1931) to represent but a single type of spicule. Always associated with small 4-armed bodies having a pyramidal or winged central process (M, middle figure), sometimes with two arms suppressed to form a spindle with a median projection (M, top and bottom figures).

E. The *Placogorgia*-type (genera *Placogorgia* Studer and *Paramuricea* Kölliker: Deichmann, 1936, pp. 134, 141).—Similar to the *Paramuricea*-type but usually the root is more strongly developed laterally and somewhat curved to fit the calicular wall, and the spine is thick, comparatively blunt, and conspicuously serrated or laciniated. Usually smaller than the typical thorn-scales of *Paramuricea* (C, upper figure) but occasionally surpass them in size, in which cases the root is more complicated and its branches coalesce more or less completely. In *Placogorgia* they are found in combination with simple spindles both small (K) and excessively large (H), large and small unilaterally spinose spindles (I, J, and L, lower figure), and marginally lobate scales (N, lower figure). Some species of *Paramuricea* have *Placogorgia*-type thornscales combined with lobated scales (N, the two upper figures), indicating that some generic reallocation may be necessary.

F. The *Trachymuricea*-type (genus *Trachymuricea* Deichmann, 1936, p. 132).—The laciniated spine projects obliquely from a root that is only a simple spindle. Always in combination with small spindles having a conical external process (L, upper two figures) much like some of the cortical sclerites of *Villogorgia*. Only two species known at present, both of them further distinguished from species of *Paramuricea* and *Villogorgia* by a very high collaret.

G. The *Echinogorgia*-type (genera *Echinogorgia* Kölliker, *Plexauroides* Wright and Studer, and *Paraplexaura* Kükenthal: Kükenthal, 1924, pp. 124, 130, 198).—A simple, stellate type of thorn-scale in which the projecting spine is greatly expanded into a thin leaf as in *Echinogorgia* and *Plexauroides* (three stages of modification are shown in G, bottom to top) and sometimes much thickened as in *Paraplexaura*. Since it is possible to trace the development of the foliate thorn-scales found in *Plexauroides* and some species of *Echinogorgia*, and the massive thorn-scales of *Paraplexaura* from the simple, stellate type of some Echinogorgias, it seems obvious that these genera are inseparable. The thorn-scales may be the predominant type of sclerite, or they may be combined with simple or unilaterally developed spindles (I and K). The generic distinctions are somewhat vague and dependent largely upon the development of the anthocodial armature, which is said to relegate *Echinogorgia* to the Paramuriceidae, and *Plexauroides* and *Paraplexaura* to the Plexauridae. Inasmuch as the anthocodial spiculation may be reduced in those species of *Echinogorgia* that have a thick rind into which the polyps retract fully, just as it is in the species of *Plexauroides* and other plexaurids that have thick rinds, it is a character of no value at the generic and familial levels. At this time it remains a moot point whether all of these species should be transferred to one family or the other; it is certainly improbable that they will continue to span two families.

CORTICAL SCLERITES

The basic type of cortical spicule is the simple spindle (K), which may grow excessively large (H), and by flattening and expansion of the margins develop into thick plates or thin scales (N). Simple spindles usually occur even in those species that have characteristically modified cortical sclerites, although in certain species they

FIG. 1.—Types of calicular thornscales (A–G) and cortical sclerites (H–N), and their various combinations (1–14): A, Calicular thorn-scales of *Menella rubescens*; B, of *Echinomuricea indomalaccensis*; C, of *Placogorgia tribuloides* (left) and *Paramuricea placomus* (right); D, of *Villogorgia zimmermani* (above) and *V. nigrescens* (below); E, of *Placogorgia tenuis* (above) and *P. atlantica* (below); F, of *Trachymuricea hirta*; G, of *Echinogorgia flexilis* (top and middle) and *E. pseudosassapo* (bottom); H, cortical sclerite of *Placogorgia mirabilis*; I, of *Placogorgia tribuloides*; J, of *Placogorgia rudis* (above) and *Thesea flexilis* (below); K, of *Paramuricea placomus* (above) and *Placogorgia atlantica* (below); L, of *Trachymuricea kükenthali* (top and middle) and *Placogorgia tenuis* (bottom); M, of *Villogorgia zimmermani* (top and middle) and *V. nigrescens* (bottom); N, of *Paramuricea grandis* (top), *P. echinata* (middle), and *Placogorgia dendritica* (bottom). 1, spicular combination found in the genus *Menella*; 2, in *Echinomuricea*; 3, in *Placogorgia* (some species); 4, in *Placogorgia* (some species); 5, in *Placogorgia* (some species); 6, in *Trachymuricea*; 7, in *Placogorgia* (some species); 8, in *Placogorgia* and *Paramuricea* (some species); 9, in *Placogorgia* (some species); 10, in *Placogorgia* (some species); 11, in *Echinogorgia*; 12, in *Echinogorgia*; 13, in *Villogorgia*; 14, in *Paramuricea* and some species of *Placogorgia*.

may be largely suppressed by the thorn-scales of the calicular region, which then dominate throughout the rind (*Echinomuricea* and *Echinogorgia*). A common sculptural modification found in several genera and species is the unilaterally spinose spindle (J, L) which may become very large (I).

It may be useful to summarize the types of thorn-scales in the form of a dichotomous key to serve as a guide to the holaxonian genera having these peculiarly modified sclerites. As in the discussion above, *Bebryce* is not included because its superficial layer of rosettes and deeper layer of stellate plates render it absolutely unmistakable.

1. Cortex consisting of a single layer of spicules in the form of large, flattened spindles or plates. Thorn-scales around calicular aperture with a stout, rough, sometimes branched spine arising from a rather small, tuberculate base
Genus ACANTHACIS Deichmann

Cortex consisting of an outer layer of spicules, large or small, and a more or less complete inner layer of smaller spicules surrounding the axis.....2

2. Calicular thorn-scales noticeably broader than high, the root-part developed mostly at right angles to axis of calicle, with two main, spreading branches curved to fit the calicular wall; projecting portion consisting of several radiating folia or a laciniated, digitate process (Fig. 1, D). Cortex containing 4-armed bodies with a pyramidal, sometimes foliate central process; sometimes modified into simple spindles with median process (Fig. 1, M)
Genus VILLOGORGIA Duchassaing and Michelotti

Calicular thorn-scales typically higher than wide, not with two main diverging roots curved to fit the calicular walls.....3

3. Calicular thorn-scales are spindles with an obliquely set, more or less laciniated, pyramidal process near the distal end (Fig. 1, F)
Genus TRACHYMURICEA Deichmann

Calicular thorn-scales with a flattened, branched, lobed or platelike base.....4

4. Projecting portion of the calicular thorn-scales is usually a single spine.....5

Projecting portion of the thorn-scales is a foliate expansion sometimes lobed or cleft into broad fingers (Fig. 1, G), sometimes thickened into a massive head..Genus ECHINOGORGIA Kölliker

5. Projecting spine of the calicular thorn-scales is a smooth or nearly smooth, tapered spike...6

Projecting spine of the thorn-scales is an echinulate or laciniate digitate process.....7

6. Projecting spike of calicular thorn-scales gradually merging into root portion, which consists of several irregularly divided branches (Fig. 1, A).....Genus MENELLA Gray

Projecting spike of thorn-scales abruptly set off from the root portion, which consists of four or five widely diverging, slender branches (Fig. 1, B).....Genus ECHINOMURICEA Verrill

7. Root portion of the calicular thorn-scales consists of several tuberculate lobes more or less completely fused together; projecting spine echinulate or strongly laciniate (Fig. 1, E). Cortical plates and spindles often with one or more strong spines..Genus PLACOGORGIA Studer

Root portion of the thorn-scales consists of several diverging branches not extensively fused together; projecting spine echinulate (Fig. 1, C, right hand figure). Cortical spindles usually without spinous projections
Genus PARAMURICEA Kölliker

PLACOGORGIA TRIBULOIDES, n. sp.

Figs. 2–9; 15

Diagnosis.—Calicular thorn-scales nearly 2 mm in length, projecting spine about 1 mm. Cortical spindles large (1.5 mm+), flattened, especially near branch tips, with several stout projecting spines. A single pair of large bent spindles and some small accessory rods in each opercular sector; collaret with 3–6 rows of transverse spindles. Branching dichotomous.

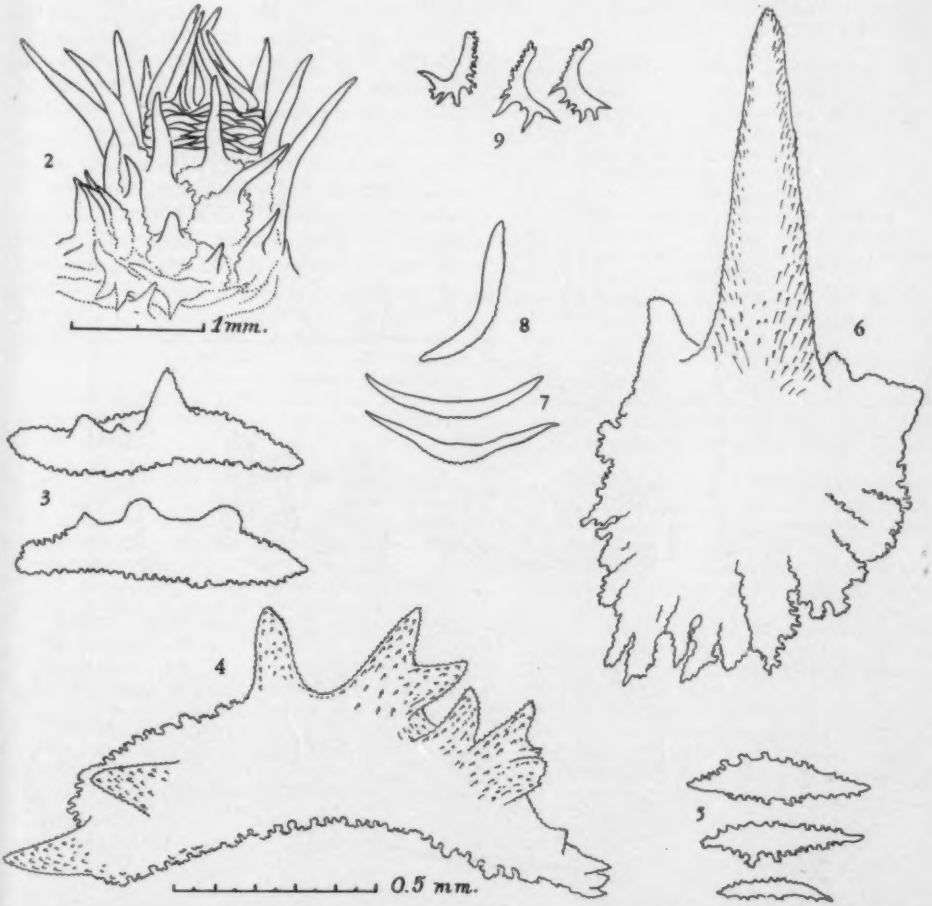
Description.—The type is a small, nearly complete colony measuring 5 cm from base to tip of the tallest branch. Ramification is in one plane and dichotomous; the main stem bifurcates within 5 mm of the base and both branches again bifurcate at about 10 mm from the first division. Further dichotomies are asymmetrical, since not all the branches subdivide. The trunk has a diameter of 2.5 mm, the major branches 1.5 mm (exclusive of calicles), and the terminal twigs about 1.0 mm (excluding calicles). Most of the calicles are inclined toward one face of the colony (the "front"), and are closely set, their bases almost touching one another. The calicles are low cylinders filled with very stout, acute, imbricating thorn-scales (Fig. 2). The anthocodiae are armed with a prominent, conical operculum consisting of a ringlike collaret usually 3–5 spicules in height, surmounted by eight points each made up of one pair of large, bent spindles of subequal size, and some small accessory rods.

The coenenchyme has a dense outer layer of glassy, irregularly tuberculate spindles, the larg-

est of which bear one to several strong, sharp, projecting spikes. Toward the branch tips some of these become broad and platelike, with several spines, closely resembling the sclerites of certain species of *Paracis*. Between and beneath the large outer sclerites there are small, irregular spindles that form a discontinuous inner layer.

Spicules.—(a) Cortex: roughly tuberculate, coarse spindles with one or several outward projecting, finely echinate processes (Fig. 3). Near the calicles these sclerites increase in size, reaching a length of 1.5 mm or longer, and bearing several stout processes some of which may be marginal (Fig. 4). Toward the branch tips, the large deposits may become quite broad and platelike, after the manner of *Paracis*. Lying between and beneath the large deposits are numerous smaller spindles, more or less flattened and with irregular edges (Fig. 5), forming a discontinuous axial sheath.

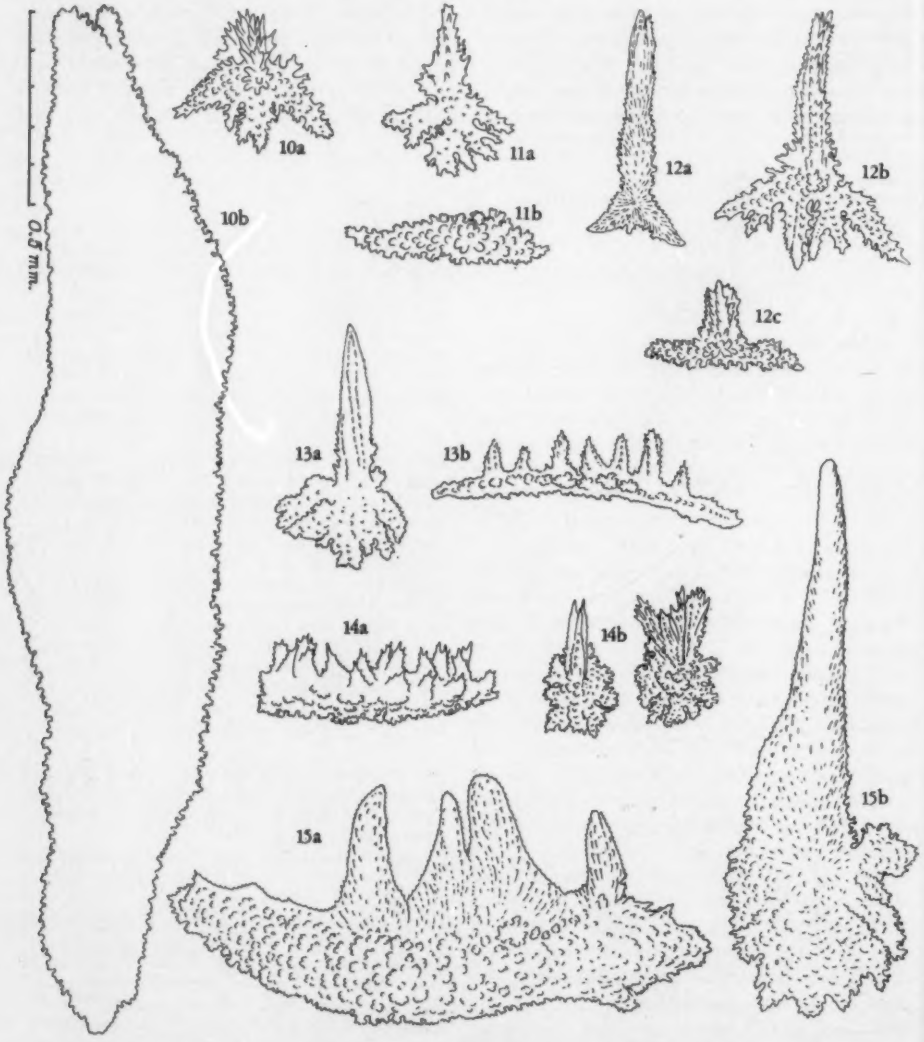
(b) Calicles: large thorn-scales with a stout, sharp, echinulate spine arising from the distal margin (Fig. 6). The broad, tuberculate basal part of the scale may have a width of 0.8 mm, and the spine may exceed a length of 1 mm.



FIGS. 2–9.—*Placogorgia tribuloides*, n. sp.: 2, Side view of calicle with operculum; 3–4, cortical sclerites; 5, spindles of axial sheath; 6, calicular thorn-scale; 7, spindles of collaret and 8, of points; 9, spicules from the tentacles. All spicules enlarged to scale shown beneath Fig. 4.

Their appearance *in situ* on the calicles is shown in Fig. 2.

(c) Polyps: the collaret contains about 5 transverse rows of curved spindles, in smaller polyps as few as 3 rows, in larger individuals as many as 5 or occasionally 6 rows. In polyps of average size they have a length of 0.5 mm (Fig. 7). Surmounting the collaret, the eight opercular points contain one pair of large, bent spindles about 0.5 mm long (Fig. 8) and another pair or two of smaller but similar accessory rods. The appearance of the closed operculum, partly retracted within the calicle, is shown also in Fig. 2. The tentacles contain the small, flat, bent rod-



FIGS. 10–15.—Spicules of *Placogorgia*: *P. mirabilis* (10a, calicular thorn-scale; 10b, cortical spindle); *P. atlantica* (11a, calicular thorn-scale; 11b, cortical spindle); *P. tenuis* (12a, crutch-shaped rod from opercular sector; 12b, calicular thorn-scale; 12c, cortical sclerite); *P. rudis* (13a, calicular thorn-scale; 13b, cortical sclerite); *P. placoderma* (14a, cortical sclerite; 14b, calicular thorn-scales); *P. tribuloides* (15a, cortical sclerite; 15b, calicular thorn-scale).

lets with laciniated edge that are characteristic of paramuriceid genera (Fig. 9).

Color.—White, the light brown axis showing through the translucent spicules.

Holotype.—U.S.N.M. no. 10204. Straits of Florida, off Havana, Cuba: 23° 10′ 39″ N., 82° 20′ 21″ W., 204 fathoms, January 19, 1885; collected by tangles. *Albatross* station 2335.

Remarks.—Four other species of *Placogorgia* are known to occur in the Atlantic: *Placogorgia atlantica* Wright and Studer, *P. mirabilis* Deichmann, *P. rudis* Deichmann, and *P. tenuis* (Verrill). *Placogorgia tribuloides* differs from all these species in the large size of its thorn-scales, which approach the type found in *Paramuricea*. That genus, however, lacks the large cortical spindles or plates with serried processes. *P. tribuloides* further differs from *P. mirabilis* in the absence of excessively large (4 mm) spindles in the cortex; from *P. rudis*, which has similar cortical spindles, by its large and sharp thorn-scales; and from *P. tenuis* by the frequent development of several spines on the cortical spindles and the lack of the single large, crutch-shaped rod in the opercular segments. These differences may be set forth in the form of a dichotomous key:

1. Cortex contains large spindles up to 4 mm in length, clearly visible to the unaided eye (Fig. 10b). Anastomosis of branches frequent
Placogorgia mirabilis Deichmann

Largest spindles of cortex less than 2 mm in length. Anastomosis of branches infrequent or absent.....2

2. Operculum usually with a single large, crutch-shaped rod (Fig. 12a) in each sector. Cortical spindles up to approximately 0.6 mm in length, usually with only one projecting process (Fig. 12c), sometimes none
Placogorgia tenuis (Verrill)

Operculum with at least two large, bent spindles in each sector, not a single crutch-shaped rod.....3

3. Cortical spindles small, usually not exceeding a length of 0.5 mm, without a row of prominent external spines (Fig. 11b). Thorn-scales 0.5 mm long, spine 0.3 mm, sharp and aculeate (Fig. 11a)
Placogorgia atlantica Wright and Studer

Cortical spindles larger, up to 1.5 mm in length, many of them with a row of spines (Figs. 13b, 15a).....4

4. Calicular thorn-scales large, 1.7 mm over-all, with a strong, sharp spine as much as 1 mm in length (Fig. 15b)
Placogorgia tribuloides, n. sp.

Calicular thorn-scales smaller, usually not more than 0.5 mm over-all, spine stout, mostly blunt or moderately sharp (Fig. 13a), commonly 0.2–0.25 mm long and rarely up to 0.4 mm, often with several prominent terminal subdivisions.....*Placogorgia rudis* Deichmann

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ARCHEOLOGY SALVAGE PROGRAM IN CHATTAHOOCHEE VALLEY

Five thousand years of buried history are represented in the lower valley of the Chattahoochee River of Alabama and Georgia, which soon will be inundated by a group of dam-created reservoirs. This is indicated in a preliminary survey by archeologists of the River Basin Surveys—joint project of the Smithsonian Institution, National Park Service, and Corps of Engineers—to explore sites of archeological and historic significance which will be flooded in extensive dam-building plans.

Largest of the areas to be inundated will be the Walter F. George Basin, named for the late senior senator from Georgia. The survey revealed 117 sites in Georgia and 90 on the Alabama side of the Chattahoochee, and they are to be explored more thoroughly—the most worthwhile with extensive excavations—before the Army engineers complete their work.

These sites range from simple Indian village locations to areas containing remains of several different cultures, and from single mounds in which Indians buried their dead to multiple groups of mounds surrounding ceremonial plazas. There also are two historic sites of considerable importance. One is the Spanish fort of Appalachicola, dating from 1689 to 1691, and the other the historic Creek Indian town of Roanoke, which was occupied by white settlers and then attacked and burned by the Indians in 1736. The fort will lie just outside the pool area, but, because the exact dates of its occupancy are known, it will be tested as it should provide an important check point in working out the chronology of the area. The remains of Roanoke also will be helpful in that respect and should be quite productive of archeological specimens. Plans are being made to start excavations there this spring.

The Indian sites in the Walter F. George Basin date from about 4,000 B. C. to relatively late Creek villages of the period from 1675 to 1836. These latter present the possibility of a specific identification of sites from ethno-historical and other documentary evidence.

Two other Chattahoochee Valley dams are also under construction—the Columbia Dam, which is another project of the Army Engineers, and the Oliver Dam of the Georgia Power Co. The basins to be flooded by these reservoirs are an integral part of the picture and must be studied in conjunction with the Walter F. George Basin. Work is just beginning at the Columbia Dam, while the Oliver Dam is virtually completed and will be closed in April. Two River Basin Survey parties will start excavations at the Columbia Dam site in February. Complete coverage of that Basin was not possible in the preliminary survey, but 14 sites were located. One, a major mound probably dating from about 300 years before Columbus, already is half destroyed by the river and will be the scene of operations of one of the field parties. The University of Georgia is cooperating in the salvage program and since last fall has been testing a series of sites in the Oliver Basin. Much useful information has been obtained. The work there has been supported by a grant from the Georgia Power Co.

Only sporadic archeological work has been done in the Chattahoochee area in the past, and an extensive program of excavations is indicated. In addition to the University of Georgia, Alabama and Florida institutions probably will cooperate with the Smithsonian Institution and the National Park Service in the salvage program.

GRASS PRIMER REPRINTED

The Smithsonian Institution announces the publication of a new edition of *First Book of Grasses*, by Dr. Agnes Chase, one of the world's foremost agrostologists. Formerly botanist of the United States Department of Agriculture and now honorary Fellow of the Smithsonian Institution, Mrs. Chase will observe her ninetieth birthday on April 20, 1959. Much of her scientific work has appeared in this JOURNAL.

Since it first appeared in 1922, this book has been the companion of succeeding generations of

beginning students of grasses. It has been out of print for several years. The present revised (3d) edition, 150 pages in length, contains 94 of the author's drawings of grasses, plus a frontispiece reproduced in color of Albrecht Dürer's painting "Das grosse Rasenstück." Dr. Leonard Carmichael, Secretary of the Smithsonian Institution, has contributed a new Foreword.

Clarence Raymond Shoemaker

March 12, 1874—December 28, 1958

Love of the outdoors and natural history ran strong in the Shoemaker family, staunch, thrifty, purposeful Quaker farming folk who originally settled in Cheltenham, Pa., in the days of William Penn. Some became businessmen, others millers; a few became well-known naturalists.

Clarence Shoemaker's grandfather, George, who left Pennsylvania for Georgetown in 1818, was a miller, who controlled the former Columbia Flour Mills. He served as local flour inspector for 48 years and, interestingly enough, was an amateur horticulturist and fruit grower. Clarence's first cousin, Ernest (1866–1957), became a well-known coleopterist. His exceptionally fine personal collection of beetles, butterflies, and moths was bequeathed to the U. S. National Museum, while his extensive collection of American Indian arrowheads went to the American Museum of Natural History in New York.

Clarence's bent for natural history developed early on spacious grounds graced with forest trees, ornamental shrubbery, and gardens surrounding his home in then bucolic Georgetown. The place was always alive with birds far beyond what one can find today in that now more settled area. Here he lived from the age of seven until his death, December 28, 1958, at the age of 84. It was quite natural that in his teens he should become one of the very early members of the Washington Audubon Society. As one of its most dedicated and ornithologically knowledgeable members, he was much sought after as a bird-walk leader. Equally interested in native wild flowers, he was also for many years an active and enthusiastic participant in the botanical "excursions" conducted by the Wildflower Preservation Society. Moreover, the Foundry Flour Mill, managed by his father, Francis Dodge Shoemaker, and his uncle, David, which supplied large quantities of flour to the Federal Government during the Civil War, was situated on Foundry Branch near the crossing of the first Potomac aqueduct, between the river and the Chesapeake and Ohio Canal, from which it drew its waterpower. Though scarcely a quarter of a mile beyond the town that then was Georgetown, it was an unspoiled wooded area where wildlife and flowers abounded and where virtually all the local species of either could be found at one season or another.

Shoemaker was educated in a private school in Georgetown. From this he went for a year to the Western High School but graduated from Central three years later, in 1897. In this latter school he received his first formal instruction in biology. He also took (1910–1911) collegiate work in that subject at George Washington University but did not continue, for, as he expressed it, he already knew more zoology than was then taught to undergraduates there. That rather comprehensive knowledge he had gained in the field and through his long association with the Smithsonian Institution.

It was quite natural that, as a young man born in Washington and with his interest in natural history, he should turn to the Nation's pioneer scientific establishment nearby in search of a future. The first opening that came his way, however, was a clerkship in the Smithsonian's International Exchange Service of which an older cousin, Coates W., was the chief. Given this opportunity, he further developed another interest—spiders—that he had earlier acquired on the home and mill grounds. Not only did he continue assiduously to collect them and build up an extensive library of arachnid literature, but he so well mastered the systematics of the group that he was soon recognized as an authority on the local fauna. As a consequence, he was frequently called upon by the U. S. Department of Agriculture and others to identify spiders. Later his spider collection was left to

the National Museum and is incorporated in its larger study collections.

In 1910 Dr. Mary J. Rathbun, in charge of the marine, aquatic, and terrestrial invertebrates in the National Museum, gave him his first opportunity for full-time zoological work as scientific aide in her division. He was promoted to assistant curator in 1921 and associate curator in 1942. Retiring in 1944 at the age of 70, he was given the honorary title of research associate in the Smithsonian Institution. It was Miss Rathbun who assigned to him the study of the vast and largely, at the time, unworked collection of amphipod crustaceans to which he thereafter rather closely devoted the rest of his life. Though relinquishing his interest in spiders and giving somewhat less attention to his fieldwork with birds and flowers, he continued to maintain his very colorful iris garden. In its heyday it was one of the show places in Old Georgetown.

Throughout his life Mr. Shoemaker was an active member of the Audubon and the Wildflower Preservation Societies already mentioned, the Biological Society of Washington, the Washington Biologists' Field Club, the American Association for the Advancement of Science, and the Washington Academy of Sciences to which he was elected in 1939. He was also a member of the American Ornithologists' Union and a charter member of the American Society of the Mammalogists and of the Society of Systematic Zoology.

His scientific reports on the Amphipoda figuratively covered the world, for, because of his very special knowledge of that group of crustaceans, he received collections for study from a number of important scientific expeditions. Among these expeditions are to be numbered the South Georgia and Belgian Congo Expeditions and the biological survey of Porto Rico and the Virgin Islands of the American Museum of Natural History in New York; the Bermuda Expeditions of the New York Zoological Society; the Canadian Cheticamp and Hudson Bay Expeditions; the Canadian Arctic Expedition, the U. S. Antarctic Expedition of 1939–1941; the Point Barrow, Alaska, Expedition; various West Indian expeditions, including his own to the Florida Keys and the American Virgin Islands; the Johnson-Smithsonian Expedition to the Porto Rican Deep; and the Presidential Cruise to the Galápagos Islands. Up to the time of his retirement he had published 56 papers on these forms, and since that occasion some 14 others. Beyond these, by the time of his first serious illness preceding his death by a bare three weeks he had completed and illustrated several additional manuscripts that are about ready for the printer except for typing. The very last of these contained the descriptions of two new and unusual species of amphipods taken on the Smithsonian-Bredin Caribbean Expedition in the spring of 1958.

He was a meticulous worker. His desk and laboratory table (they were one), his instruments and optical equipment, notes, card files, and publications were left in excellent order. There have been few specialists on amphipods who knew them as well, loved them as much, and described and figured them as carefully as Mr. Shoemaker. He was his own artist, and his drawings were exceedingly clear and accurate; no essential detail was ever glossed over or overlooked.

As a kindly, unassuming friend, and a scientifically productive individual, he will long be remembered by his colleagues in this Museum and coworkers elsewhere around the world.—WALDO L. SCHMITT.